

529,123

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 April 2004 (08.04.2004)

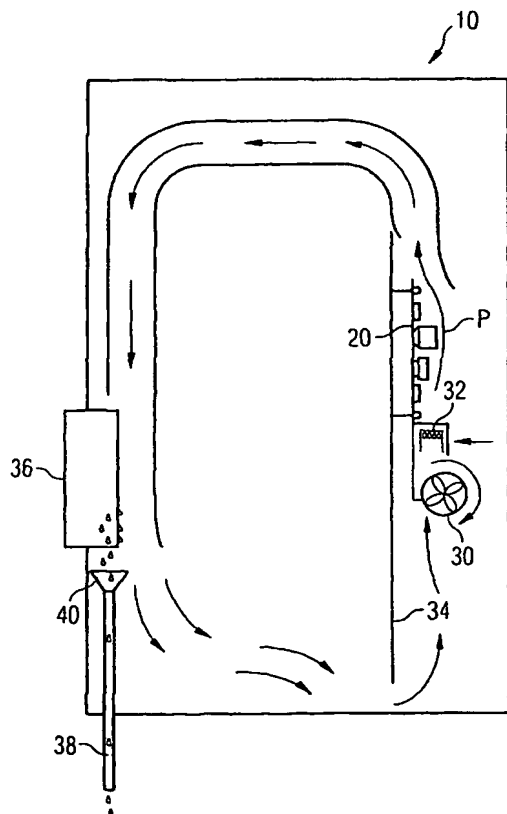
PCT

(10) International Publication Number
WO 2004/029450 A1

- (51) International Patent Classification⁷: **F03D 11/00**,
H05K 7/20
- (21) International Application Number:
PCT/EP2003/010674
- (22) International Filing Date:
25 September 2003 (25.09.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
102 45 103.6 27 September 2002 (27.09.2002) DE
- (71) Applicant (for all designated States except US): **GENERAL ELECTRIC COMPANY** [US/US]; 1, River Road, Schenectady, NY 12345 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **ACHENBACH**,
- (74) Agents: **ZIMMERMANN, Gerd et al.**; Postfach 330 920, 80069 Munich (DE).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,

[Continued on next page]

(54) Title: DEHUMIDIFYING OF AIR WITHIN SWITCH CABINET FOR A WIND TURBINE BY MEANS OF PELTIER ELEMENT



(57) Abstract: The invention relates to a switch cabinet for a wind turbine with at least one circuit element accommodated in said switch cabinet and a drying arrangement for preventing water depositions onto the at least one circuit element, wherein the drying arrangement includes a device for generating an air flow in a region of the at least one circuit element, the device including a peltier element.

WO 2004/029450 A1

BEST AVAILABLE COPY

WO 2004/029450 A1



SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

DEHUMIDIFYING OF AIR WITHIN SWITCH CABINET FOR A WIND TURBINE BY MEANS OF
Peltier ELEMENT

Field of the Invention

The present invention relates to a switch cabinet for a wind turbine with at least one circuit element accommodated in said switch cabinet and a drying arrangement for preventing water deposition onto said at least one circuit element as well as to a method for operating a wind turbine using such a switch cabinet.

Background of the Invention

The operating parameters of modern wind turbines, like e.g. blade angle, total orientation of the rotor and/or adjustments of the generator used for power generation, are electronically controlled. The electric or electronic circuit elements utilized therefor are usually accommodated in a switch cabinet mounted to the machine nacelle, which is disposed in a height of up to 100 m. This switch cabinet is subject to atmospheric influences. To guarantee reliable operation of the wind turbine, water should not be deposited onto the electric or electronic circuit elements during any atmospheric condition.

In prior art switch cabinets for wind turbines, this condition is ensured by heating the air in the switch cabinet to thereby prevent that the circuit boards accommodated in the switch cabinet cool down below the dew point. However, this measure is associated with high power consumption so that the profitability of wind turbine operation is significantly derogated. According to an alternative concept, desiccants are used for reducing the air humidity in the switch cabinet. However, the intake capacity of such desiccants is limited so that they need to be replaced frequently, which poses problems particularly when the switch cabinet is disposed at a height of 100 m or more. Furthermore, the reaction rate of desiccants for binding of air humidity is relatively low so that reliable prevention of water depositions onto the circuit elements cannot be achieved by this method.

vide an improved switch cabinet for a wind turbine, particularly a switch cabinet which allows for reliable operation of the wind turbine without excessive power consumption, as well as a method for operating a wind turbine using this switch cabinet.

5

Summary of the Invention

Due to an aspect of the present invention, this object is solved by an advancement of the prior art switch boards which is mainly characterized in that the drying arrangement includes a device for generating air flow in the region of the at least one circuit element.

Surprisingly, it was found that generating an air flow contributes to the prevention of water deposition onto circuit elements. This air flow can be generated with comparatively small power consumption by using a simple fan. A further improvement of operational reliability can be achieved when the drying arrangement further includes at least one heater for heating the air in the region of the at least one circuit element, because then the water vapor absorption capacity of the air is increased in the region of the at least one circuit element and, thus, the risk of condensation on the circuit element is reduced.

20

According to a preferred embodiment of the switch cabinet according to the present invention, the drying arrangement includes a cooling element for separating water from the passing air, said cooling element being spaced from said at least one circuit element, and a drain element for draining the separated water out of the switch cabinet. Thus, the air humidity within the switch cabinet is effectively reduced so that the risk of water deposition onto the at least one circuit element is counteracted. Thereby, the reduction of air humidity within the switch cabinet can be achieved in a particularly effective manner when the flow generating device is operable to generate an air flow, which circulates within said switch board and moves past the at least one circuit element as well as said cooling element, so that the air circulating within the switch board continuously absorbs humidity which is then separated at the cooling element and is drained out of the switch cabinet through a drain opening.

25

30

Peltier element mounted in the switch cabinet. In this typical embodiment of the present invention, an effective circulation of the air flow can be caused when the flow generating device includes a plate-like flow guidance element which is interspersed by the Peltier element, wherein the at least one circuit element is disposed at that side of the flow guidance element that faces the part of the Peltier element that is warmer during operation. Different atmospheric conditions can be accounted for when a control device is provided which controls the drying arrangement depending on temperature and/or air humidity within and/or outside the switch cabinet.

As can be also seen from the above explanation of a switch cabinet according to the present invention, a method for operating a wind turbine is provided, wherein at least one operating parameter of the wind turbine is controlled by at least one circuit element accommodated in a switch cabinet and deposition of condensation water onto the at least one circuit element is counteracted, said method being basically characterized in that an air flow in the region of the at least one circuit element is generated for preventing the deposition of water onto the at least one circuit element, wherein the air can be heated in the region of the at least one circuit element. In a typical embodiment of the method according to the present invention, condensation water is separated at a cooling element, which is spaced from the circuit element, and is drained out of the switch cabinet. Although passive cooling elements are also within the scope of the present invention, it was found to be particularly practical to use a Peltier element as an active cooling element while simultaneously heating the air in the region of the at least one circuit element, wherein the generation of the air flow and/or the activation of the cooling element can be controlled depending on temperature and/or air humidity within and/or outside the switch cabinet.

Brief Description of Drawings

A full and enabling disclosure of the present invention, including the best mode thereof, to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures wherein:

present invention.

Fig. 2 shows a schematic drawing of a switch cabinet according to a second embodiment of the present invention.

Detailed Description

According to Fig. 1, a switch cabinet for a wind turbine according to a first embodiment of the present invention can be realized as a fully enclosed switch cabinet having a cabinet door which is closed during operation. A number of electric and/or electronic circuit elements is situated within the switch cabinet, wherein said circuit elements can be disposed on one or more circuit boards 20 as is exemplarily shown in Fig. 1. Furthermore, a drying arrangement is also accommodated in switch cabinet 10, wherein, according to the embodiment of the present invention shown in Fig. 1, said drying arrangement includes a fan 30 disposed below the circuit board, a heater 32 disposed upstream with respect to the air flow generated by said fan 30 and behind the fan 30, a flow guide plate 34 serving as a support for circuit board 20, and a cooling element 36 disposed upstream said circuit board and at that side of the flow guide plate 34 that does not face the circuit board.

An air flow directed towards the circuit board 20 is generated by the fan 30, which is disposed in close proximity to the circuit board below thereof, and on that side of the flow guide plate 34 that faces the circuit board, wherein the air flow is heated by means of a heater 32 implemented as a heating coil so that the heated air can absorb a large amount of air humidity and no condensation of air humidity occurs on the circuit board. After moving past circuit board 20, the air flow is deflected within switch cabinet 10 and then moves past cooling element 36 which is disposed on the side of flow guide plate 34 not facing circuit board 20.

In the embodiment according the present invention shown in Fig. 1, cooling element 36 is implemented as a passive cooling element and consists basically of a body made of heat conducting material, e.g. copper or aluminum, which is in contact with the ambient air outside

of humidity contained in the passing air occurs if the ambient temperature drops to a value below the dew point, i.e. to a value of about 5°C or below. The water separated at the cooling element 36 is drained out of the switch cabinet 10 by means of a drain conduit 38, wherein the condensation water is collected by a hopper 40 disposed at the upper end of the drain conduit 38.

The drying arrangement shown in Fig. 1 is appropriately controlled by a corresponding control device, which can also be accommodated in switch cabinet 10, so that the operation of fan 30 and heater 32 are not started until the ambient temperature has dropped to a value of 5°C or below and/or the air humidity within and/or outside the switch cabinet exceeds a value of 80%. The operation of the drying arrangement may be stopped when the air humidity attained a value of less than 70%. Compared to prior art drying arrangements, which required heating of the total internal space of the switch cabinet to prevent condensation of water on the circuit elements, the switch cabinet 10 shown in Fig. 1 can be operated with less power consumption, because heating is required only in the region of the circuit board and, simultaneously, continuous drying of the switch cabinet by condensation of air humidity at the cooling element 36 and draining of the condensation water by means of the drain conduit 38 is caused by the air circulating within switch cabinet 10 and moving past cooling element 36.

The second embodiment according to the present invention shown in Fig. 2 differs from the embodiment shown in Fig. 1 mainly in that a heater in the form of a Peltier element 130 is used instead of the heater in the form of a heating coil. The Peltier element 130 is arranged so that its warmer side 132, in an operating condition, is disposed on the same side of flow guide plate 34 as circuit board 20. The air heated by the warmer side 132 of Peltier element 130 moves past circuit board 20 and is deflected by a flow conduit 35 so that it moves past the cooler side 136, in an operating condition, of Peltier element 130 at the side of flow guide plate 34 not facing circuit board 20. Thereby, the Peltier element is used as an active cooling element, wherein the water contained in the air circulating within the switch cabinet condenses at its cooler side and is collected by means of a hopper 40 and is subsequently drained out of the switch cabinet via a drain conduit 38. The arrangement shown in Fig. 2 allows the drying of the air contained in the switch cabinet even at ambient

temperature when the air humidity within the switch cabinet exceeds a predetermined limit value of, e.g., 80%. Peltier element 130 and fan 30 may be automatically stopped by a respective control device when the air humidity attains a value of 70% or less. Also, a
5 combination of temperature and air humidity measurements are possible for controlling the operation of the drying arrangement.

Having thus described the invention in detail, it should be apparent that various
modifications can be made in the present invention without departing from the spirit and
10 scope of the following claims.

1. A switch cabinet (10) for a wind turbine with at least one circuit element (20) accommodated in said switch cabinet (10) and a drying arrangement for preventing a water deposition onto the at least one circuit element (20),

characterized in that

the drying arrangement comprises a device (30) for generating an air flow in a region of the at least one circuit element (20).

2. The switch cabinet (10) according to claim 1, characterized in that the drying arrangement comprises at least one heating device (32; 132) for heating the air in the neighborhood of the at least one circuit element (20).

3. The switch cabinet (10) according to claim 1 or 2, characterized in that the drying arrangement comprises a cooling element (36; 136) for separating water from air flowing by, said cooling element being spaced from said at least one circuit element (20), as well as at least one drain element (38, 40) for draining the separated water out of the switch cabinet (10).

4. The switch cabinet (10) according to claim 3, characterized in that the flow generating device (30) is operable for generating an air flow, which circulates within said switch cabinet (10) and thereby moves past the at least one circuit element (20) and the cooling element (36; 136).

5. The switch cabinet (10) according to claim 3 or 4, characterized in that the heating device (132) and the cooling element (136) comprise a Peltier element (130).

6. The switch cabinet (10) according to claim 5, characterized in that the flow generating device (30) comprises a plate-like flow guidance element (34) interspersed with said Peltier element (130), wherein the at least one circuit element (20) is disposed at a side of the flow guidance element (34) facing the warmer part of the Peltier element (130)

7. The switch cabinet (10) according to any of the preceding claims, characterized by a control device which controls the drying arrangement depending on temperature and/or air humidity within and/or outside said switch cabinet (10).
- 5
8. A method for operating a wind turbine, wherein at least one operational parameter of the wind turbine is controlled by at least one circuit element (20) accommodated in a switch cabinet (10) and wherein the deposition of condensation water onto said at least one circuit element (20) is counteracted, characterized in that an air flow is generated
- 10 in the internal space of the switch cabinet (10) in the region of the at least one circuit element (20) for preventing the deposition of water onto the at least one circuit element (20).
9. The method according to claim 8, characterized in that the air in the region of the at
- 15 least one circuit element (20) is heated.
10. The method according to claim 8 or 9, characterized in that condensation water is separated at a cooling element (36; 136) spaced from said at least one circuit element (20) and is drained out of the switch cabinet (10).
- 20
11. The method according to claim 9 or 10, characterized in that the air is heated by a Peltier element (130) which is also used as a cooling element (36; 136).
12. The method according to any of claims 8 to 11, characterized in that the generation of
- 25 the air flow, the heating of the air and/or the activation of the cooling element (36; 136) is controlled depending on temperature and/or air humidity within and/or outside the switch cabinet.

FIG 1

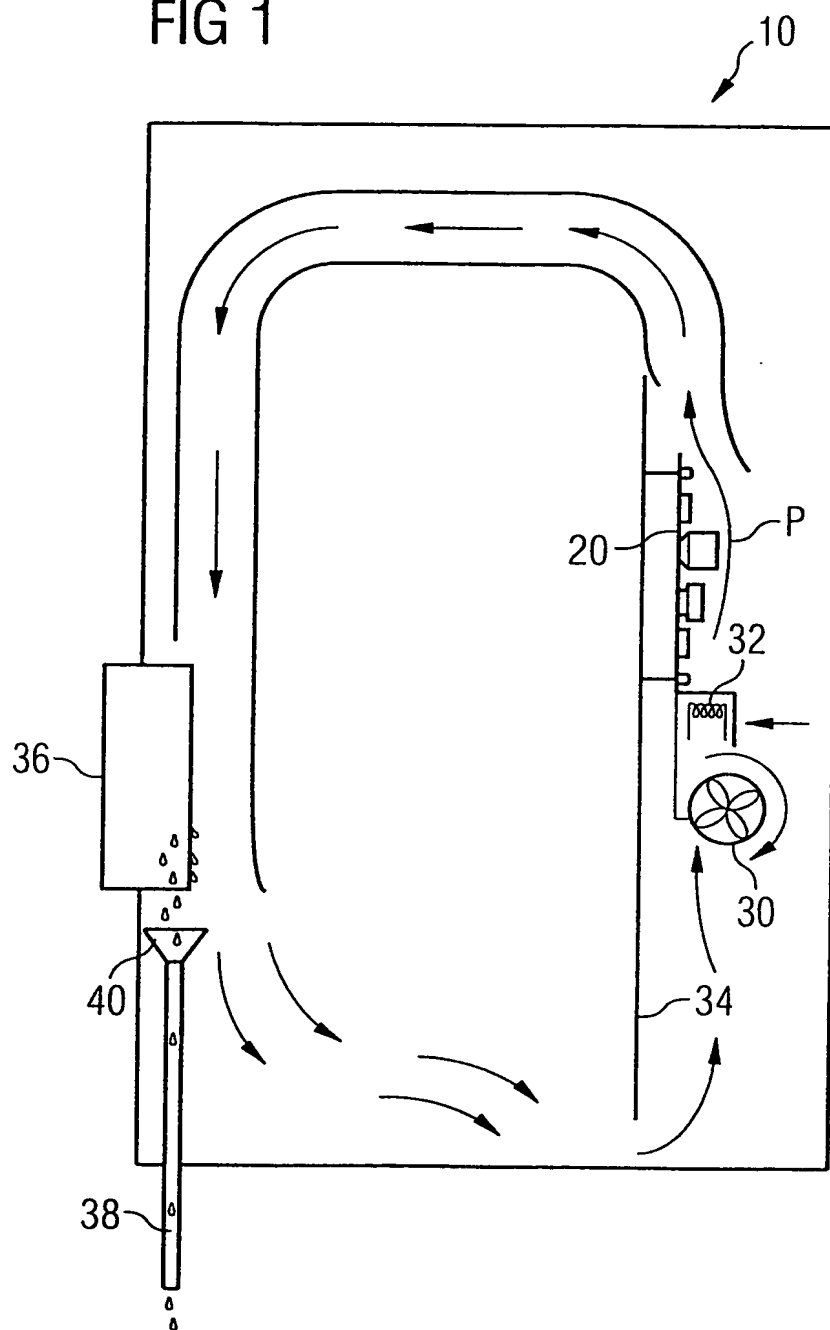
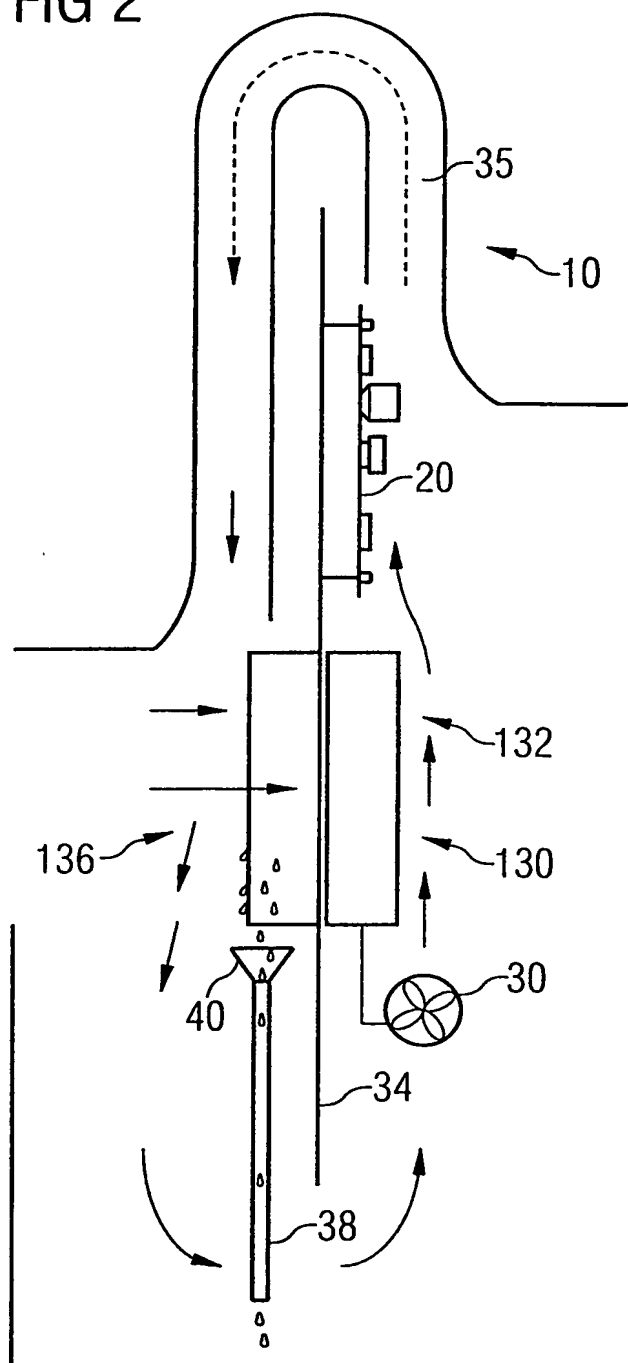


FIG 2



INTERNATIONAL SEARCH REPORT

PCT/EP 10674

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F03D11/00 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 F03D H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01/021956 A (LAGERWEY HENDRIK LAMBERTUS ; LAGERWEY WINDTURBINE B V (NL)) 29 March 2001 (2001-03-29) page 1, line 1 - line 18 page 7, line 7 - page 8, line 2 page 10, line 11 - line 28; figure 7 claim 2	1-12
Y	DE 42 28 521 A (CRUSE STEFAN) 3 March 1994 (1994-03-03) the whole document	1-12

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

* & * document member of the same patent family

Date of the actual completion of the international search

13 January 2004

Date of mailing of the international search report

20/01/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax (+31-70) 340-3016

Authorized officer

Criado Jimenez, F

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	DE 102 18 115 A (SEIFERT MTM SYSTEMS MALTA LTD) 26 June 2003 (2003-06-26) abstract paragraphs '0001! - '0003! paragraph '0006! paragraphs '0008! - '0011! paragraphs '0040! - '0046!; figure 3 -----	1-12
P,A	WO 02/086313 A (WOBLEN ALOYS) 31 October 2002 (2002-10-31) abstract page 5, paragraph 2 claim 8 -----	1
A	DE 196 21 485 A (SCHULTE FRANZ JOSEF) 12 March 1998 (1998-03-12) abstract column 2, line 66 - column 3, line 2 -----	1
P,A	DE 101 39 556 A (WOBLEN ALOYS) 27 February 2003 (2003-02-27) paragraphs '0001! - '0009! claims 1,5,10 -----	1

INTERNATIONAL SEARCH REPORT

PCT/EP/01/10674

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
WO 0121956	A	29-03-2001	NL	1013129 C2	27-03-2001
			EP	1218638 A1	03-07-2002
			JP	2003510492 T	18-03-2003
			WO	0121956 A1	29-03-2001
DE 4228521	A	03-03-1994	DE	4228521 A1	03-03-1994
DE 10218115	A	26-06-2003	DE	10218115 A1	26-06-2003
WO 02086313	A	31-10-2002	DE	10119625 A1	14-11-2002
			WO	02086313 A1	31-10-2002
DE 19621485	A	12-03-1998	DE	19621485 A1	12-03-1998
DE 10139556	A	27-02-2003	DE	10139556 A1	27-02-2003
			WO	03014629 A1	20-02-2003

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.